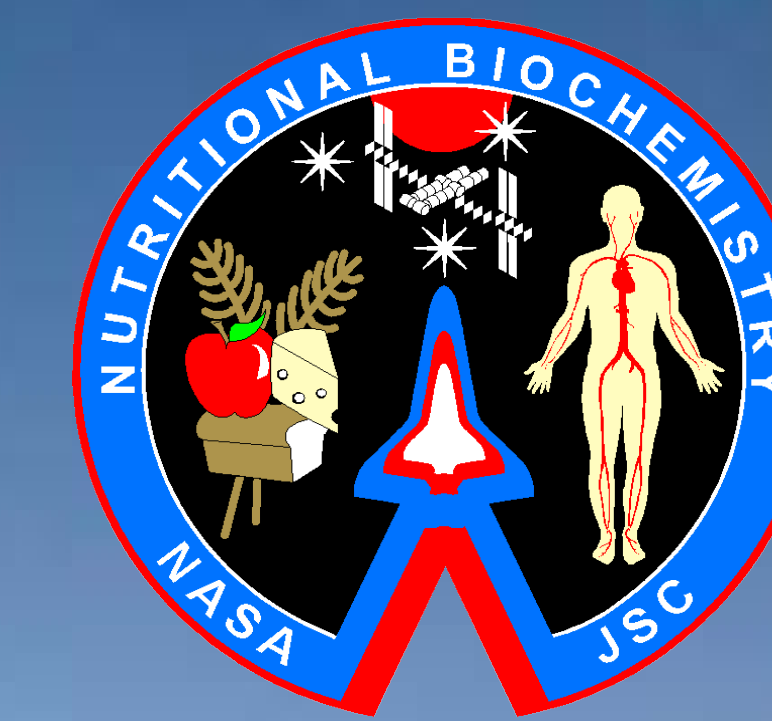


Vitamin D Supplementation and Immune Response to Antarctic Winter

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Abstract

Maintaining vitamin D status without sunlight exposure is difficult without supplementation. This study was designed to better understand interrelationships between periodic cholecalciferol (vitamin D3) supplementation and immune function in Antarctic workers. The effect of 2 oral dosing regimens of vitamin D3 supplementation on vitamin D status and markers of immune function were evaluated in people in Antarctica with no ultraviolet light exposure for 6 mo. Participants were given a 2,000-IU (50 µg) daily (n=15) or 10,000-IU (250 µg) weekly (n=14) vitamin D3 supplement for 6 mo during a winter in Antarctica. Biological samples were collected at baseline and at 3 and 6 mo. Vitamin D intake, markers of vitamin D and bone metabolism, and latent virus reactivation were determined. After 6 mo the mean (±SD) serum 25-hydroxyvitamin D3 concentration increased from 56±17 to 79±16 nmol/L and 52±10 to 69±9 nmol/L in the 2,000-IU/d and 10,000-IU/wk groups (main effect over time P<0.001). Participants with a greater BMI (participant BMI range = 19-43 g/m2) had a smaller increase in 25-hydroxyvitamin D3 after 6 mo supplementation (P<0.05). Participants with high serum cortisol and higher serum 25-hydroxyvitamin D3 were less likely to shed Epstein-Barr virus in saliva (P<0.05). The doses given raised vitamin D status in participants not exposed to sunlight for 6 mo, and the efficacy was influenced by baseline vitamin D status and BMI. The data also provide evidence that vitamin D, interacting with stress, can reduce risk of latent virus reactivation during the winter in Antarctica.

Objectives

A key objective of this study was to determine the efficacy of a once-weekly dose of vitamin D3 compared to a daily dose in maintaining 25-hydroxyvitamin D3 status. We also tested the hypothesis that vitamin D status can influence the immune response that allows increased viral reactivation among Antarctic expeditioners.

Methods

This study was conducted during winter in Antarctica at McMurdo Station. The 35 subjects recruited for this study were randomly divided into 2 groups for vitamin D supplementation: 2000 IU/d (n = 15), 10,000 IU/week (n = 14). Some subjects (n = 12) did not take supplements or took ones of their own choosing. Blood samples were collected about every 2 mo during the winter and 5-day diet logs were recorded for the 5 days prior to each blood draw. Saliva samples were collected daily for 10 days before each blood draw for analysis of viral reactivation.

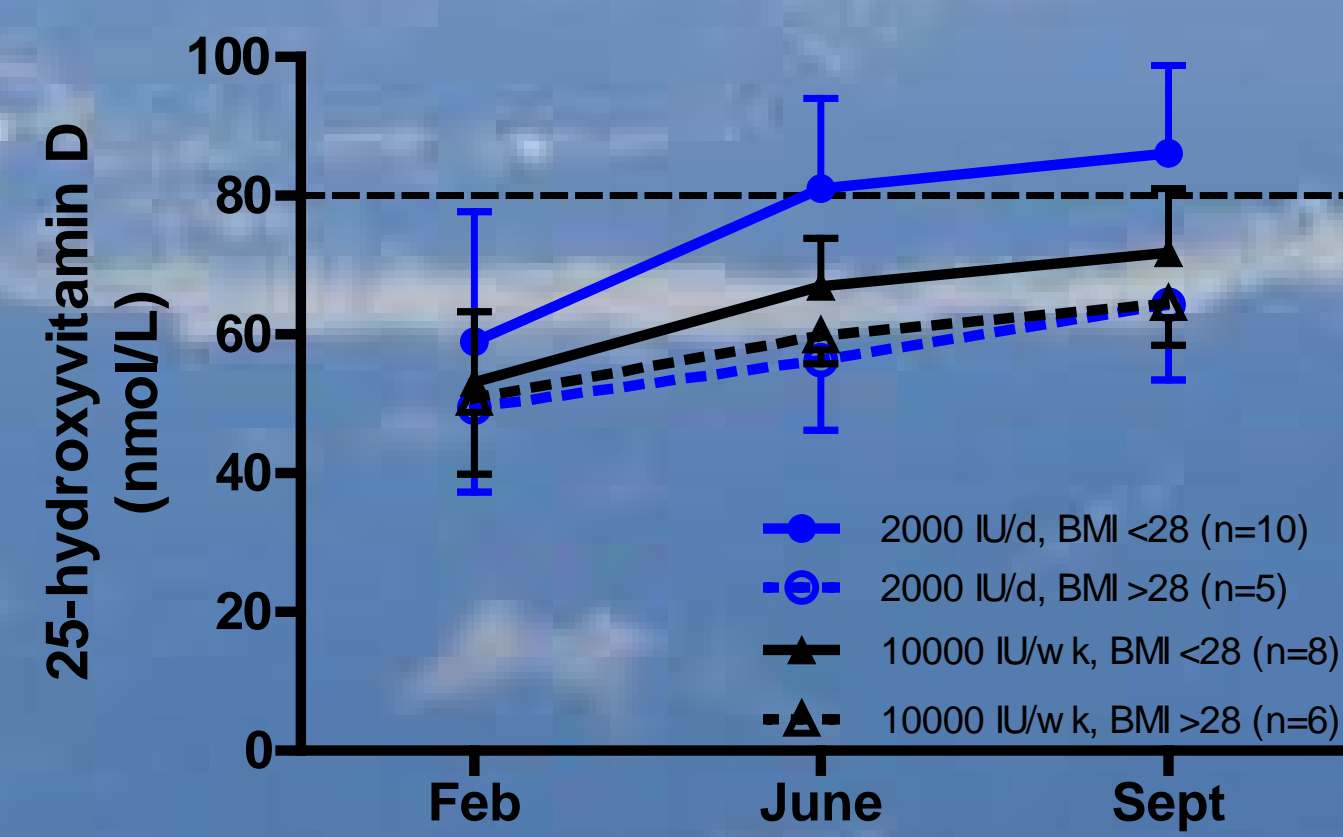
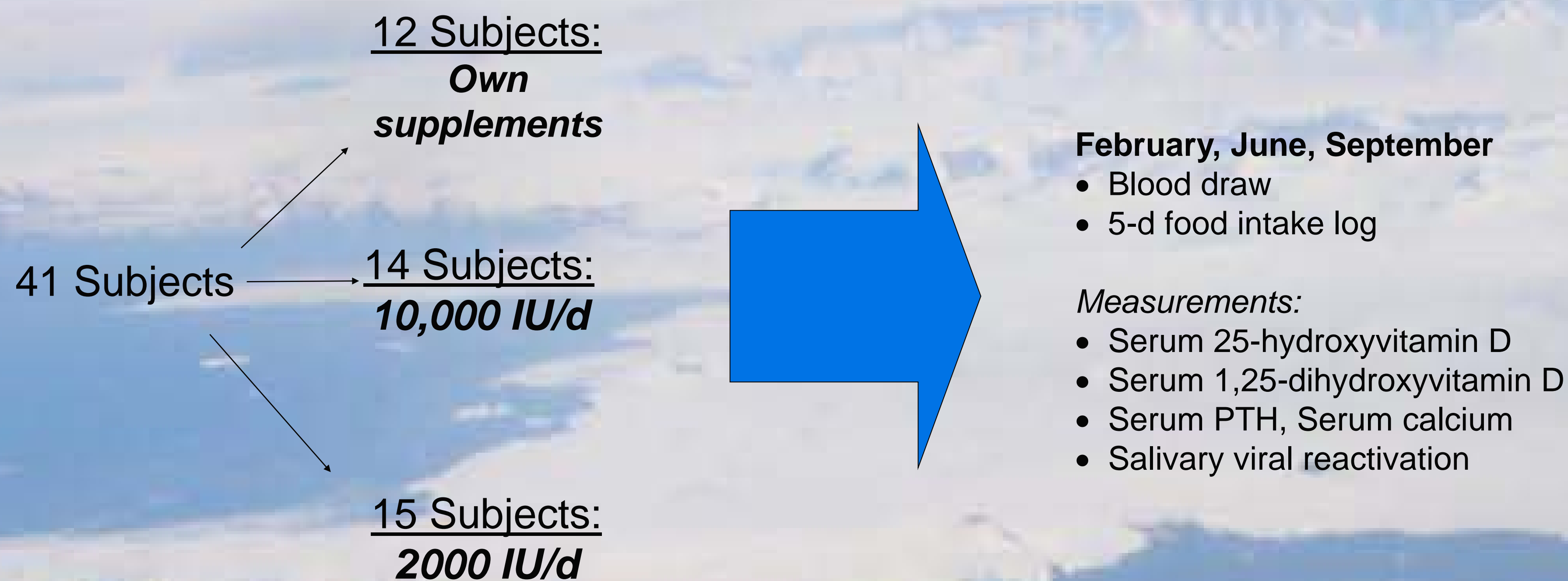


Figure 1. Serum 25-hydroxyvitamin D3, at baseline and 3 and 6 mo after supplementation began, for participants with BMI <28 kg/m² or >28 kg/m² in groups taking vitamin D3 in a once-daily dose of 2,000 IU or a once-weekly dose of 10,000 IU. Values are means ± SD. As described in the text, the data were analyzed over the continuum of BMI statistically, but were split into subgroups to visually present the relationship here. The change in serum 25-hydroxyvitamin D3 after 6 mo of supplementation was greater for participants with lower BMI than for those with higher BMI (P < 0.03).

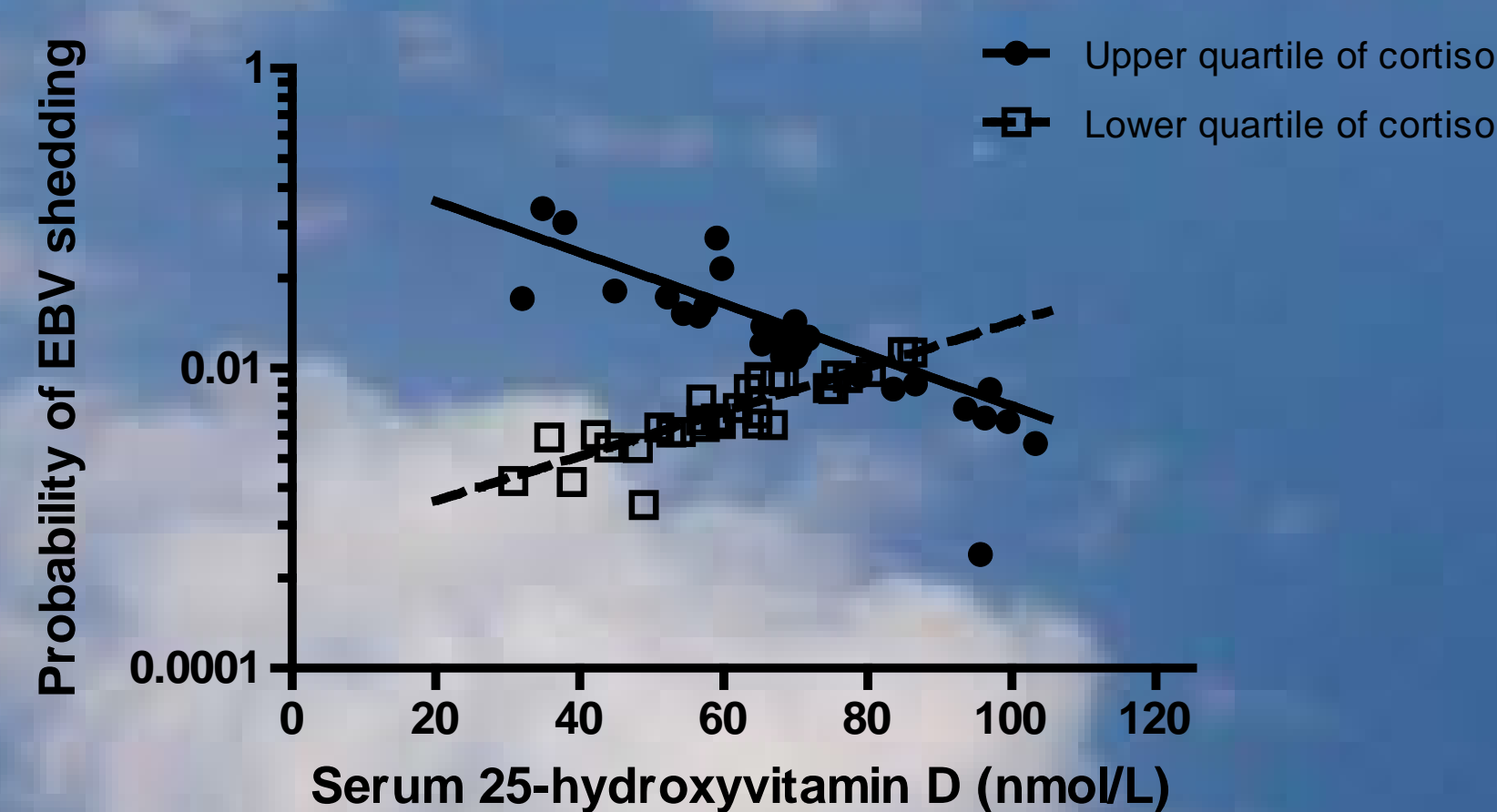


Figure 2. The interaction of serum cortisol with the relationship between study participants' 25-hydroxyvitamin D3 status and the probability of Epstein-Barr virus (EBV) shedding. Data from all 41 participants were included in this graph. As described in the text, the data were statistically analyzed over the continuum of cortisol data, but were split into subgroups to visually present the relationship here.

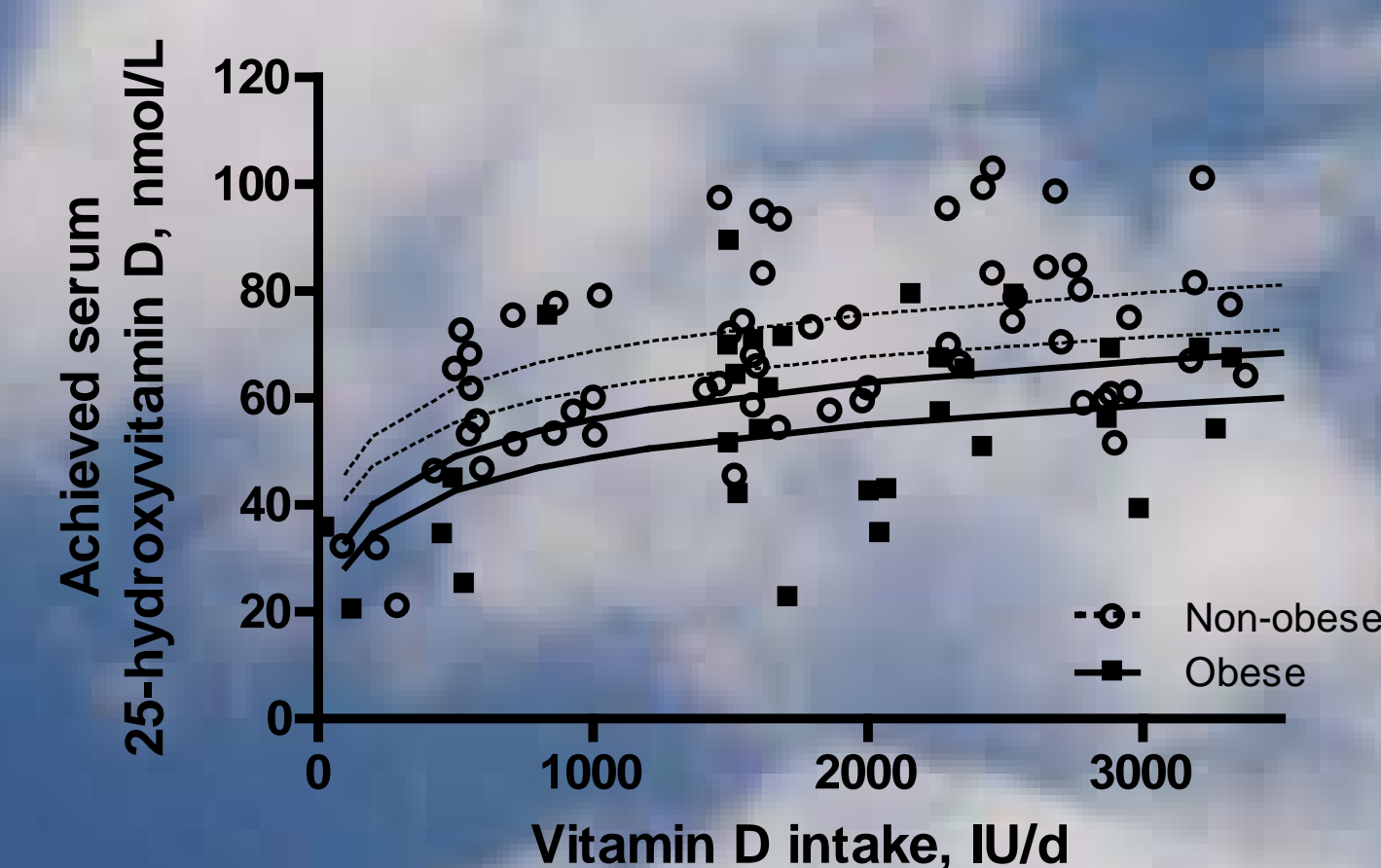


Figure 3. Response of serum 25-hydroxyvitamin D to total vitamin D intake after about 6 months of intervention. Each data point represents an individual from one of our two studies of vitamin D in the Antarctic. Predicted CIs are shown as dotted lines for non-obese (BMI < 30) subjects and as solid lines for obese subjects (BMI ≥ 30). For the obese subjects, the relationship for achieved vitamin D is 9.1 x ln (total vitamin D intake) with predicted confidence intervals (shown as dashed and solid lines) for upper and lower intervals of y = 9.4 ln (total vitamin D intake) – 12.7 ± (0.52 ln (total vitamin D intake)). For the non-obese subjects, the relationship for achieved vitamin D is 9.1 ln (total vitamin D intake) – 12.71 with predicted upper and lower confidence intervals of y = 9.4 ln (total vitamin D intake) ± 0.52 ln (total vitamin D intake).

Results

In both 2,000-IU/d and 10,000-IU/wk supplement groups, 25-hydroxyvitamin D3 was significantly higher than baseline (P < 0.001) after 3 and 6 mo of supplementation (Table 3). The group × time interaction effect was not significant (P = 0.36), suggesting that changes over time were not significantly affected by whether participants supplemented with smaller daily doses versus a large weekly dose.

The mixed-effects logistic regression model evaluating the effects of participants' serum cortisol and 25-hydroxyvitamin D3 concentrations on the probability of EBV shedding over time revealed a significant serum cortisol by 25-hydroxyvitamin D3 concentration interaction effect (P < 0.03). For individuals with high serum cortisol concentration, increasing 25-hydroxyvitamin D3 tended to reduce the likelihood of EBV shedding, relative to individuals with low serum cortisol concentration.

Summary

These data show that a once-daily 2,000-IU and a once-weekly 10,000-IU cholecalciferol (vitamin D3) supplement were equally effective in increasing vitamin D status in participants not exposed to sunlight for 6 mo. The response to supplementation depended on both BMI and baseline vitamin D concentration.

Attenuating the probability of viral shedding in persons whose immune function is compromised has the potential to have a positive impact on many people on Earth in high-stress environments as well as crewmembers during spaceflight. These data are the first to suggest that a higher vitamin D status may help protect against reactivation of latent viruses, which is associated with impairment of immune function.

Reference

- Smith SM, Zwart SR, Ploutz-Snyder R, Locke J. Letter to the Editor: Response to vitamin D intake: from the Antarctic to the IOM. J Nutrition (in press).
- Zwart SR, Mehta S, Ploutz-Snyder R, Bourbeau Y, Locke J, Pierson D, Smith SM. Response to vitamin D supplementation during Antarctic winter is dependent on BMI, and can mitigate Epstein-Barr virus reactivation. J Nutrition (in press).
- Smith SM, Gardner KK, Locke J, Zwart SR. Vitamin D supplementation during Antarctic winter. Am J Clin Nutr 89:1092-1098, 2009.

